

CLAIMS

1. A method for removing a material covering an alignment mark on a substrate,
comprising:

 mounting the substrate onto a stage in a focused ion beam system, said focused ion beam system having a non-liquid metal ion source;

 directing an ion beam at the material covering an alignment mark, said ion beam having a beam current greater than 300 nanoamps and directed at an oblique angle relative to the surface of the substrate; and

 removing said material by ion beam sputtering.
2. The method of claim 1 in which the focused ion beam system has a plasma ion source.
3. The method of claim 1 in which the ion beam is directed at an angle less than 80° relative to the substrate surface normal.
4. A method for removing a material covering an alignment mark on a substrate,
comprising:

 directing a charged particle beam at the material covering an alignment mark; and

 removing said material by charged particle beam sputtering without using an etch assisting gas.
5. The method of claim 4 in which the charged particle beam is a focused ion beam.
6. The method of claim 5 in which said focused ion beam is a beam of noble gas ions.
7. The method of claim 5 in which said focused ion beam is selected from the group consisting of an argon ion beam, a krypton ion beam, and a xenon ion beam.

8. The method of claim 4 in which the charged particle beam is directed at an oblique angle relative to the surface of the substrate.

9. The method of claim 4 in which the charged particle beam is directed at an angle of between 40° and 80° relative to the substrate surface normal.

10. The method of claim 4 in which the charged particle beam has a beam current of 300 nanoamps to 20,000 nanoamps.

11. The method of claim 4 in which the charged particle beam has a beam current of 1500 nanoamps to 5000 nanoamps.

12. The method of claim 4 in which the substrate is a silicon wafer.

13. The method of claim 4 in which the material covering an alignment mark is a metal film.

14. An apparatus for removing a material covering an alignment mark on a substrate, comprising:

a device for loading the substrate;

a device for aligning the substrate;

a device for positioning the substrate;

a charged particle beam system having a charged particle source for emitting a charged particle beam, an optical system for focusing the charged particle beam, and a computer controlled beam deflector to position the charged particle beam;

a device for controlling the charged particle beam dose applied to said material; and

a device for unloading the substrate.

15. The apparatus of claim 14 in which the charged particle beam system is a focused ion beam system.

16. The apparatus of claim 14 in which the charged particle beam system is a noble gas ion beam system.

17. The apparatus of claim 14 in which the charged particle beam system is selected from the group consisting of an argon ion beam system, a krypton ion beam system, and a xenon ion beam system.

18. The apparatus of claim 14 in which the charged particle beam is directed at an oblique angle relative to the surface of the substrate.

19. The apparatus of claim 14 in which the charged particle beam is directed at an angle of between 40° and 80° relative to the substrate surface normal.

20. The apparatus of claim 14 in which the charged particle beam has a beam current of 300 nanoamps to 20,000 nanoamps.

21. The apparatus of claim 14 in which the charged particle beam has a beam current of 1500 nanoamps to 5000 nanoamps.

22. The apparatus of claim 14 in which the device for aligning the substrate comprises an optical microscope.